

FROM MICROBES TO WHALES

AMBON: Arctic Marine Biodiversity Observing Network

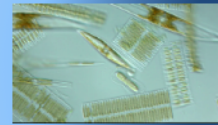
Cooper L², Iken K¹, Grebmeier J², Danielson S¹, Mueter F¹, Hopcroft R¹, Stafford K³, Kuletz K⁴, Collins E¹, Kavanaugh M⁸, Bluhm B^{1,5}, Moore S⁶, Buckelew S⁷, Bochenek R⁷

(1) University of Alaska Fairbanks, USA (2) University of Maryland Center for Environmental Science, USA (3) University of Washington, USA (4) US Fish and Wildlife Service, USA (5) University of Tromsø, Norway (6) National Oceanographic and Atmospheric Administration, USA (7) Alaska Ocean Observing System/AXIOM, USA (8) Oregon State University

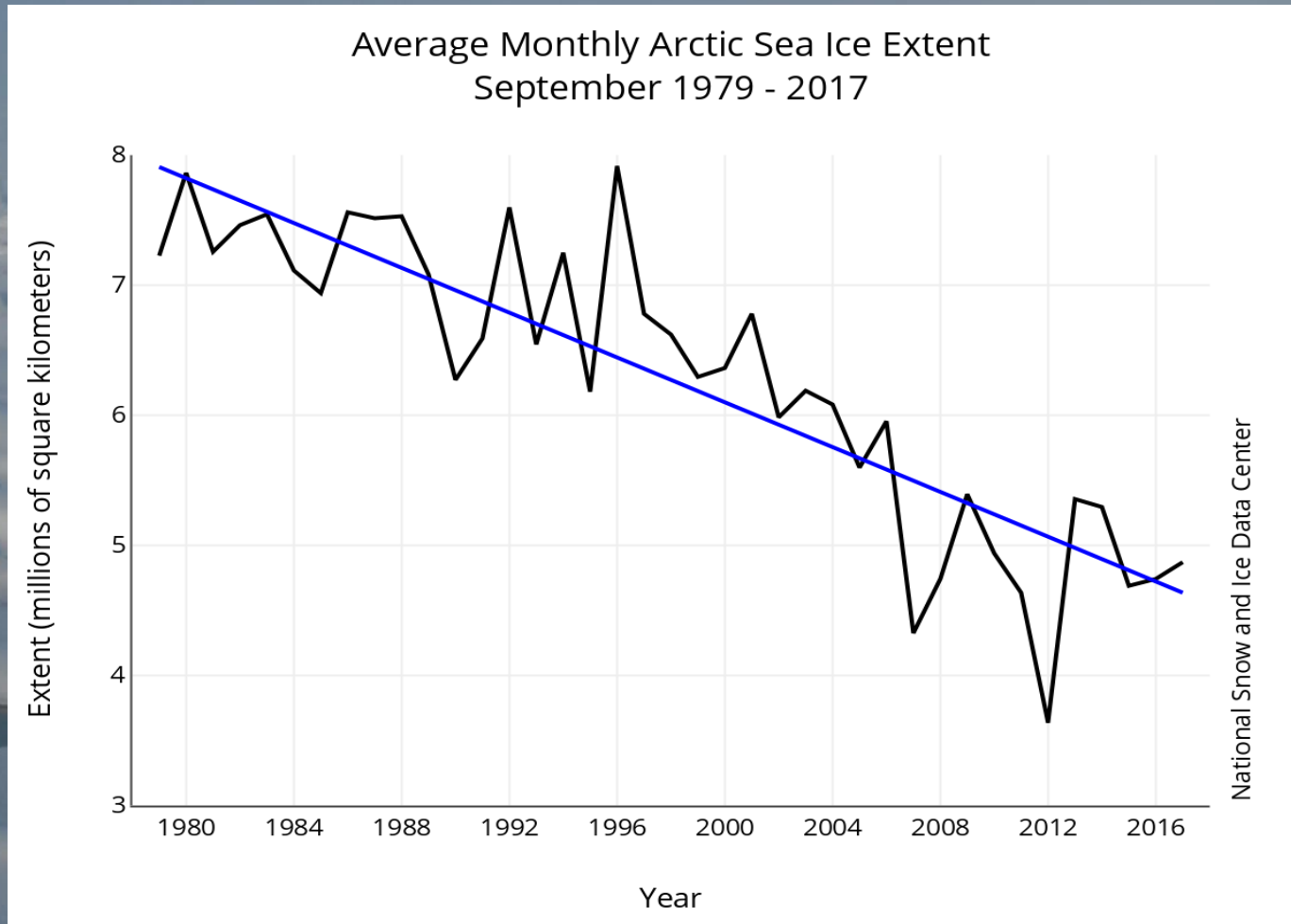


AMBON goals

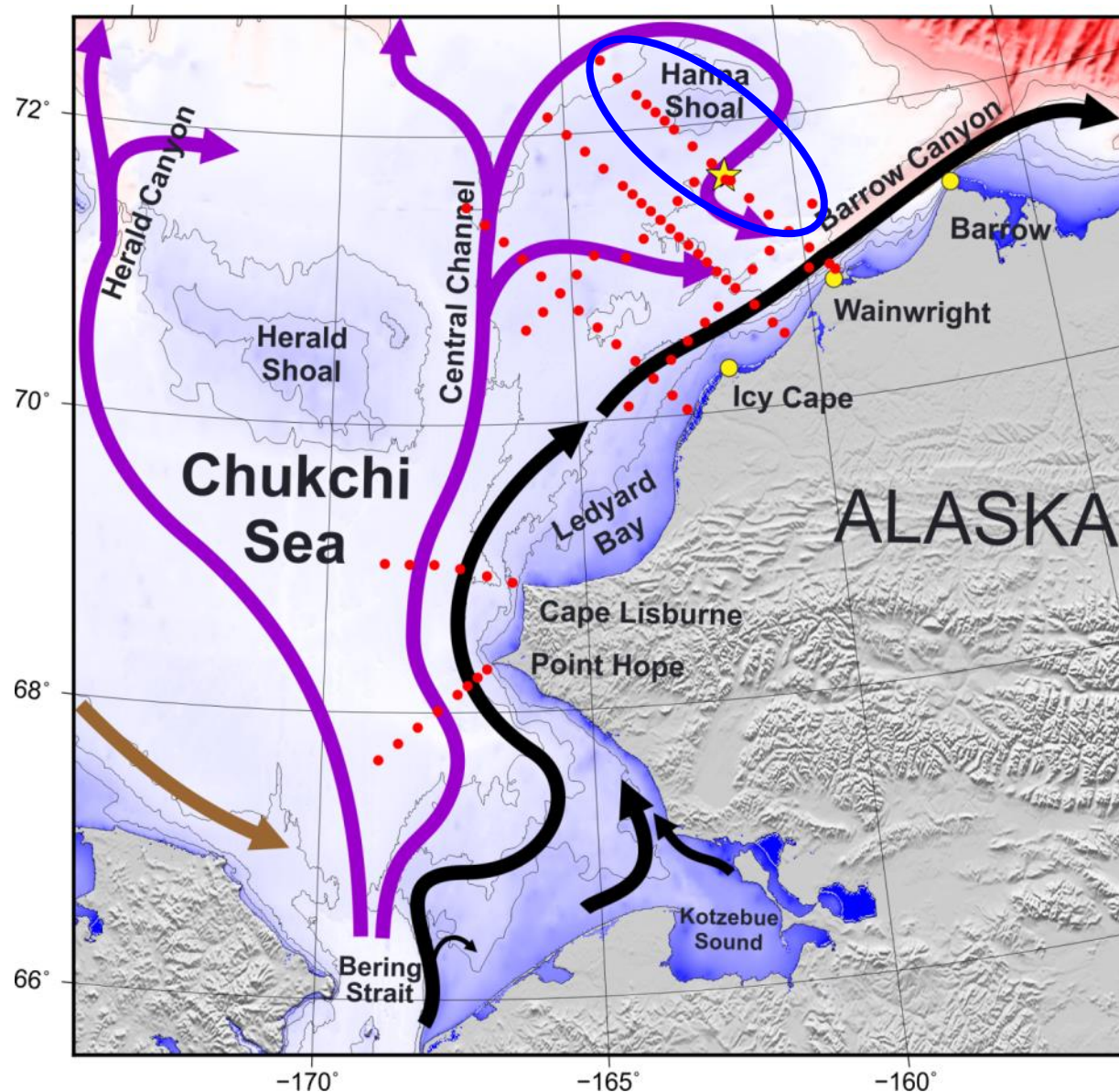
- **Measures marine biodiversity (species richness and distribution) in the Chukchi Sea**
- AMBON monitors marine diversity from bacteria to whales
- Relate species distribution to the physical environment
- AMBON builds on and continues previous/ongoing field projects:
 - Chukchi Sea Environmental Studies Program (CSESP) – *past*
 - Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) - *past*
 - Russian-American Long-term Census of the Arctic (RUSALCA) - *past*
 - Distributed Biological Observatory (DBO) – *ongoing*
 - Chukchi Sea Ecosystem Observatory (CEO) – *ongoing*



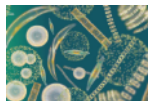
Arctic sea ice changes



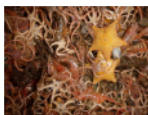
Hydrographic complexity



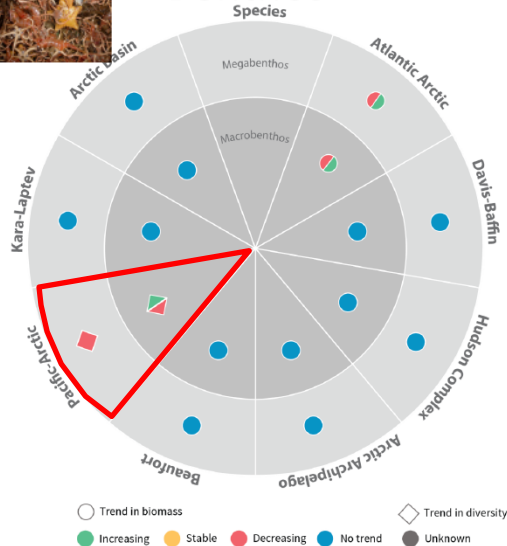
Pacific Arctic known/unknowns



Plankton



Benthos



Trends

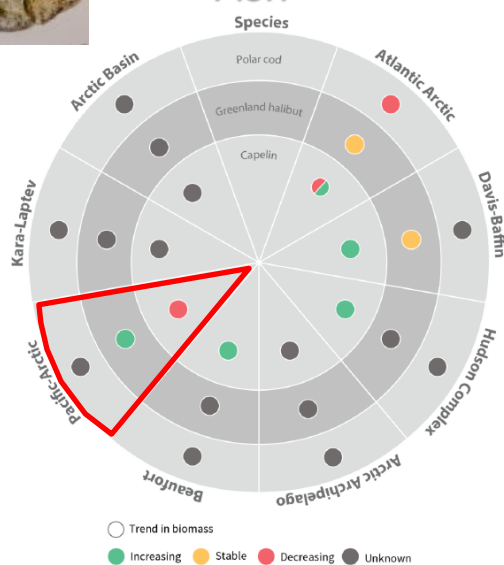
- increasing
- stable
- decreasing
- no trend
- unknown



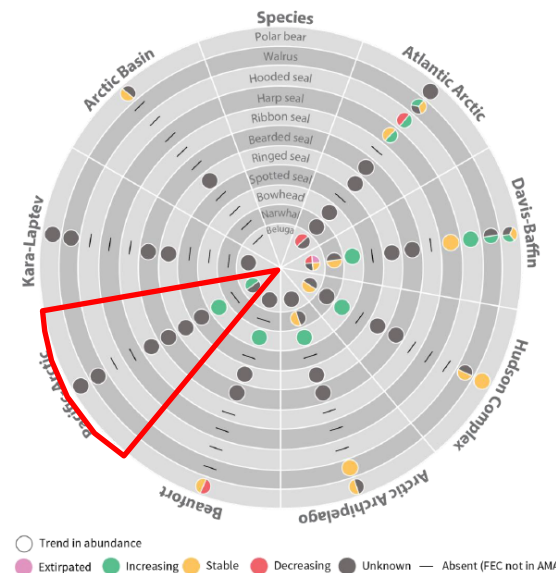
Marine mammals



Fish

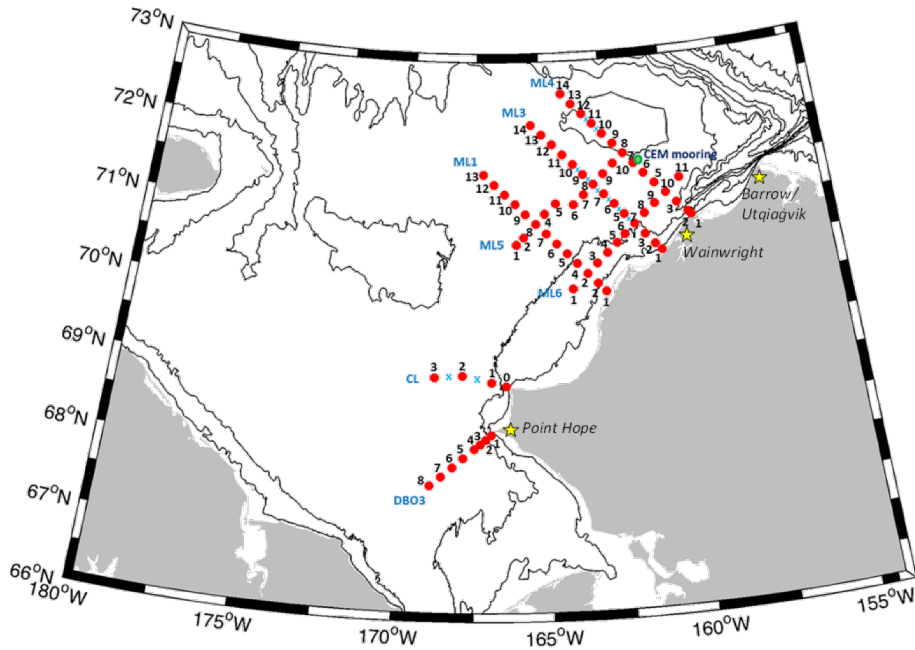


Seabirds

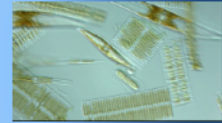
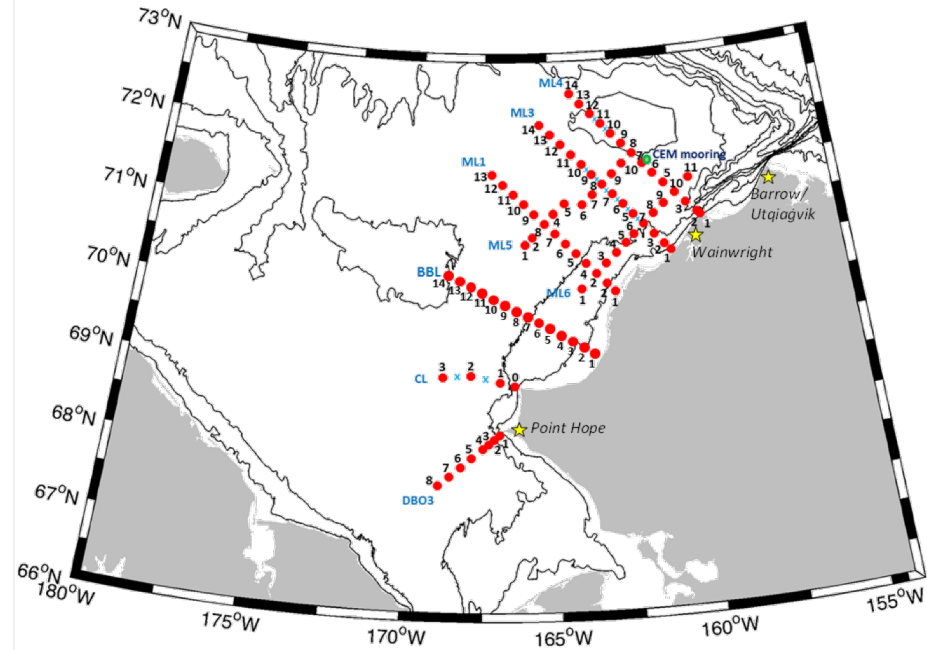


AMBON sampling grid

2015 field season



2017 field season



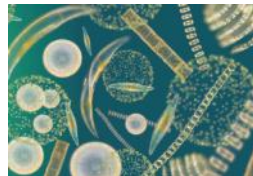
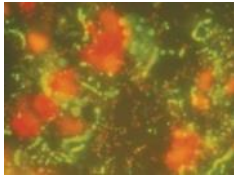
Measurements during AMBON

Physical measurements: temperature, salinity,
nutrients, chlorophyll



water collections

Plankton: microbes, phytoplankton, zooplankton



nets



Benthic organisms: macrofauna, epifauna



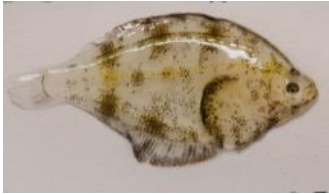
grabs



trawls

Measurements during AMBON

Fish: demersal and pelagic fish



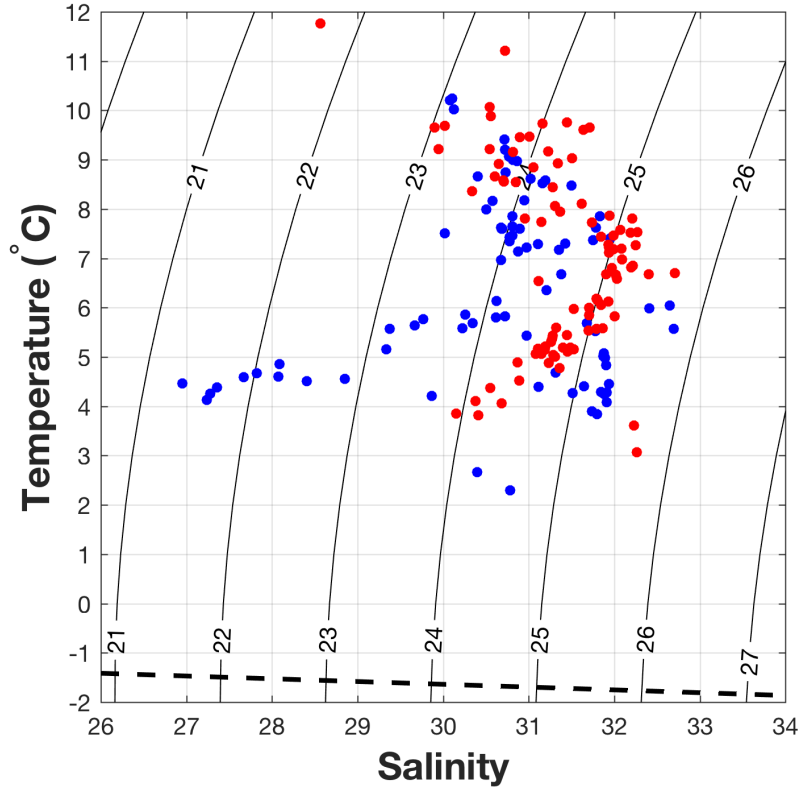
Seabirds and marine mammals: transect line observations from the ship



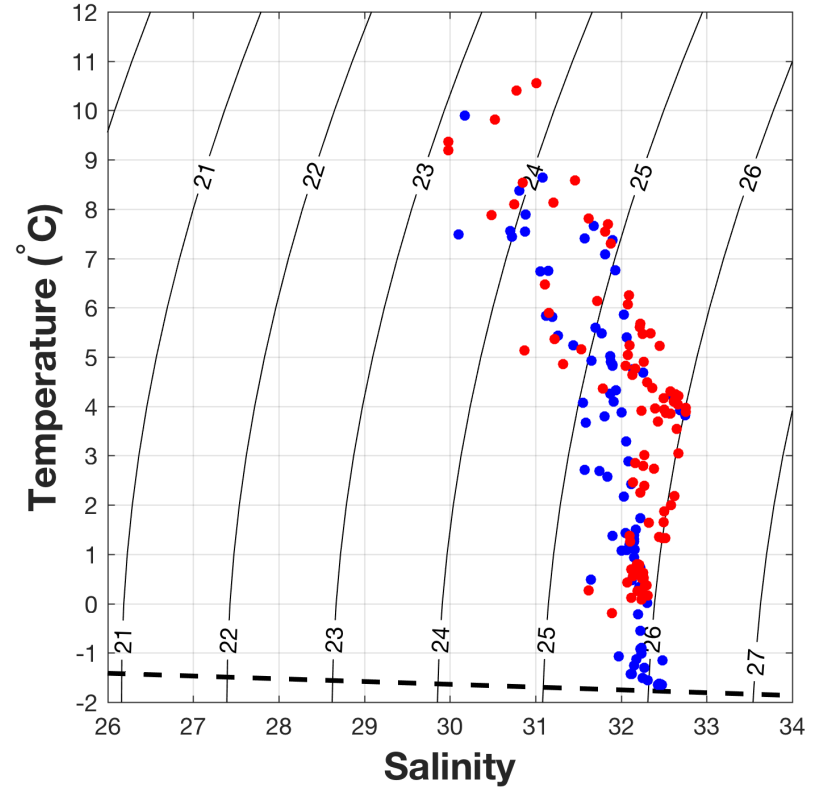
observers

Environmental conditions

Surface



Seafloor



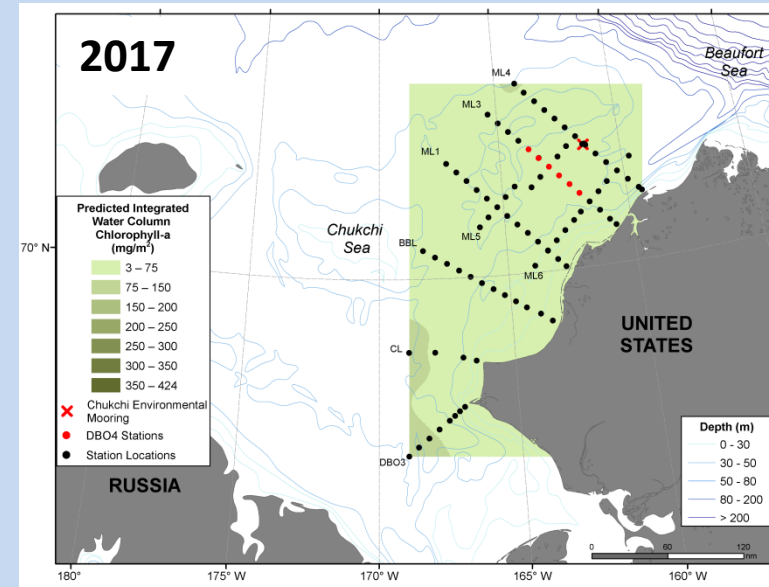
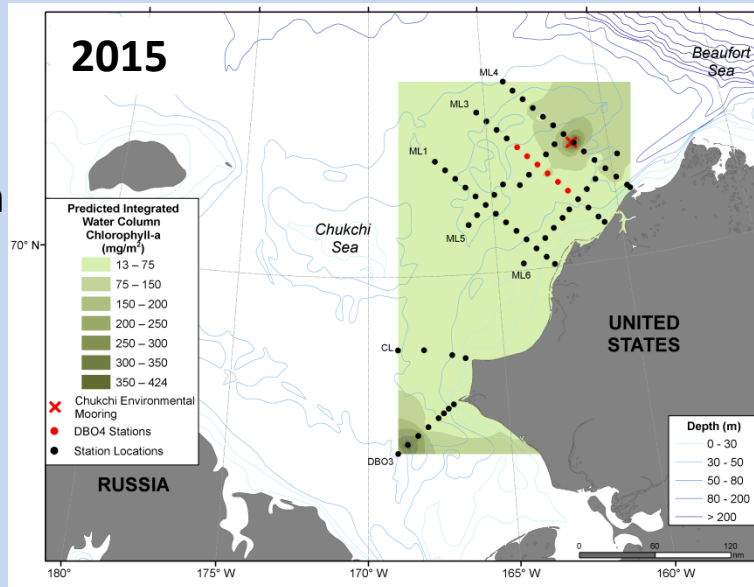
2015: fresher, colder

2017: saltier, warmer

Environmental conditions

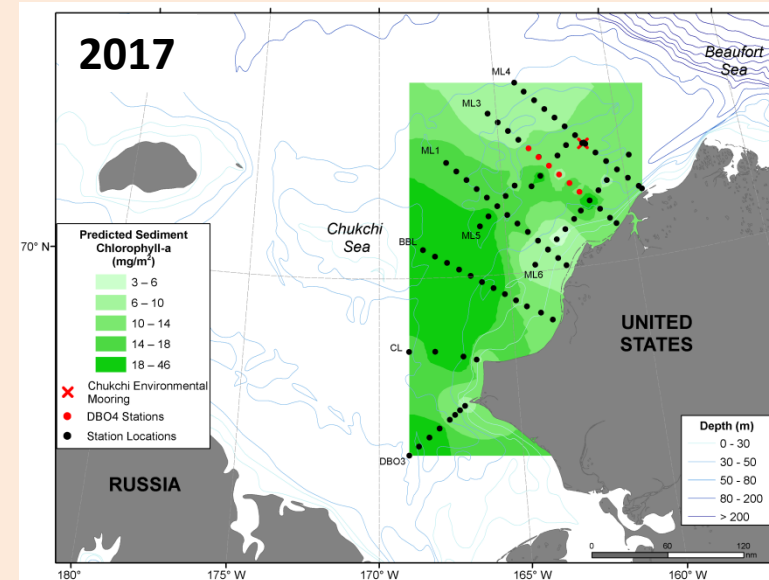
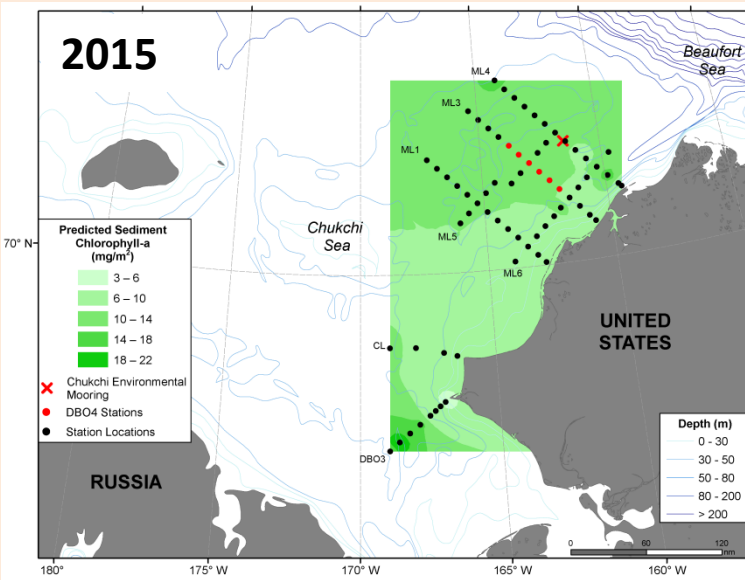
Water column chlorophyll

Higher in 2015
Bloom ongoing



Sediment chlorophyll

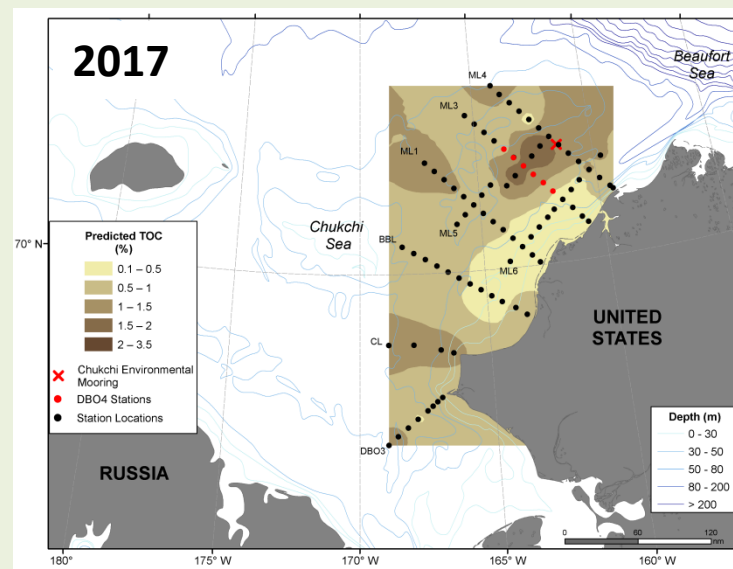
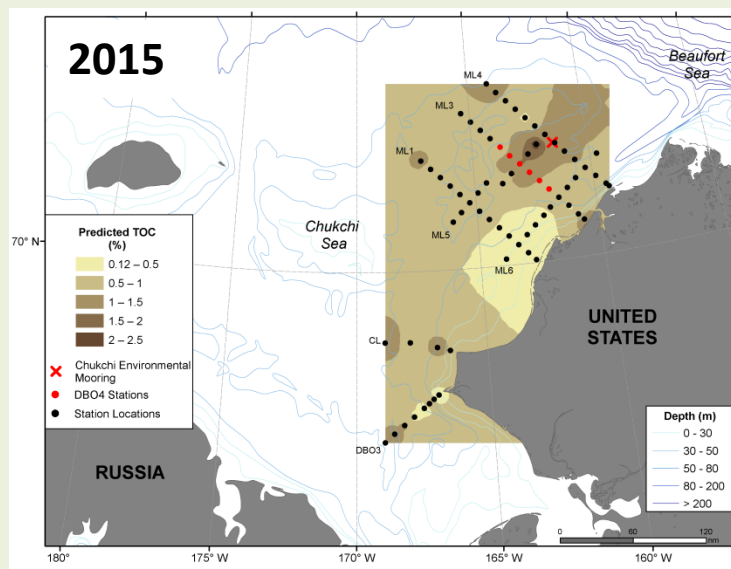
Higher in 2017
Bloom settled



Environmental conditions

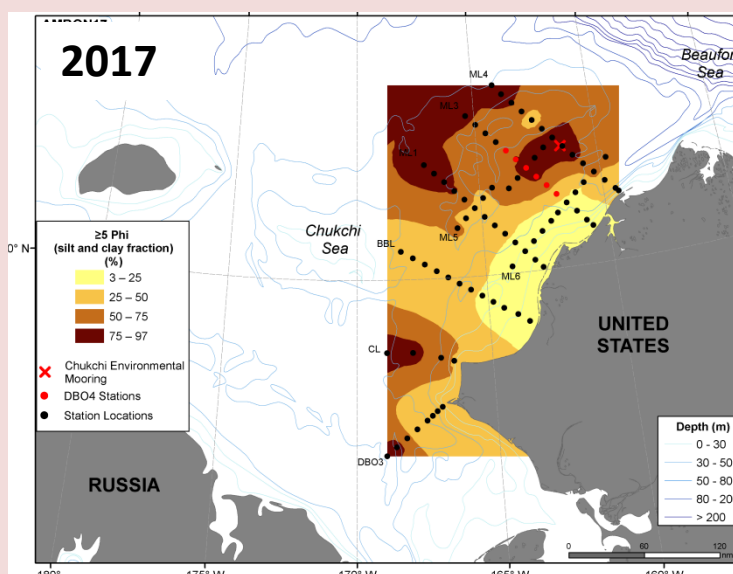
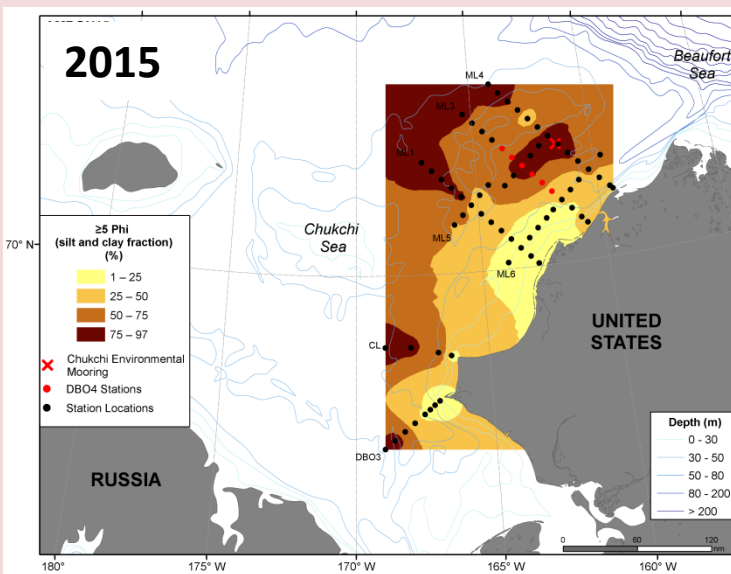
Sediment carbon (TOC)

Higher in 2017
Bloom settled
Similar overall
patterns



Sediment grain size ($\geq 5 \phi$)

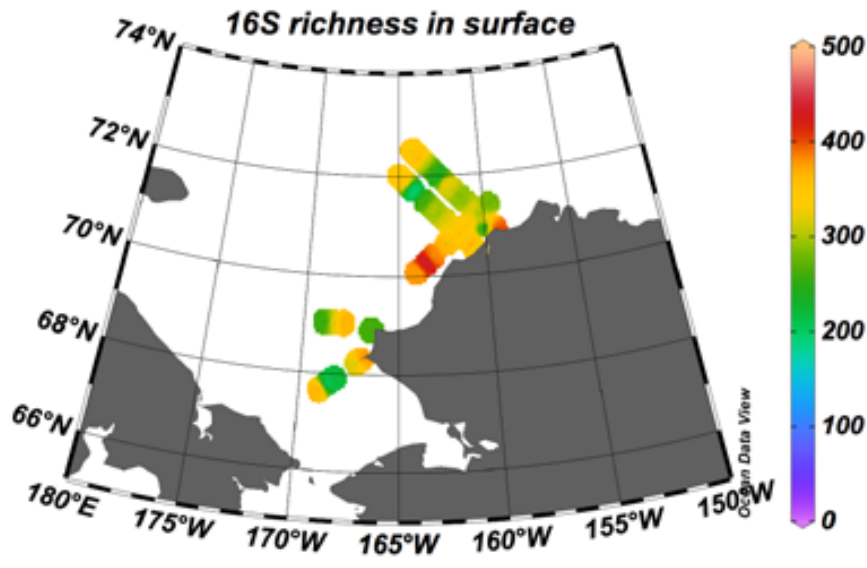
Similar patterns



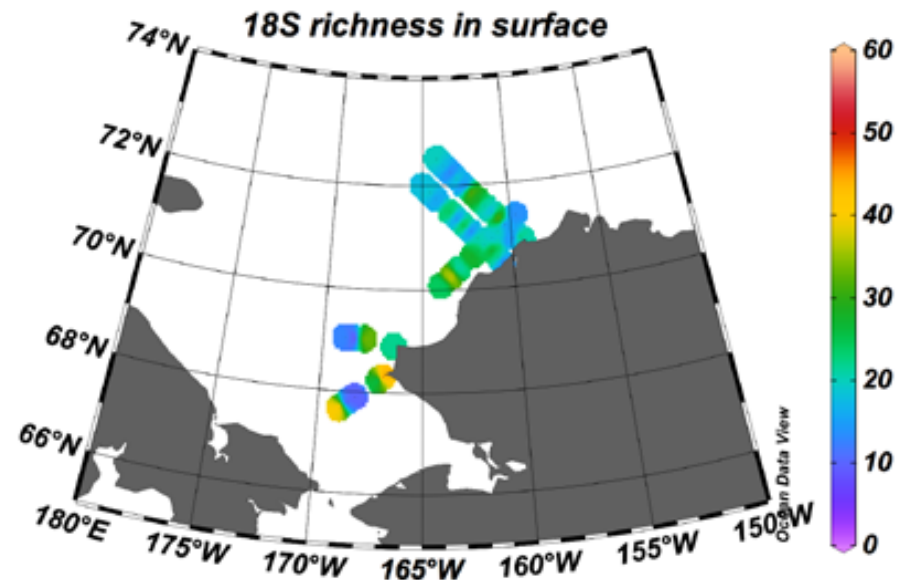


- Bacterial diversity orders of magnitude higher than other single-celled taxa such as phytoplankton
- Strong association of some taxa / OTU to water mass characteristics (temperature, salinity, nutrients)

Bacteria



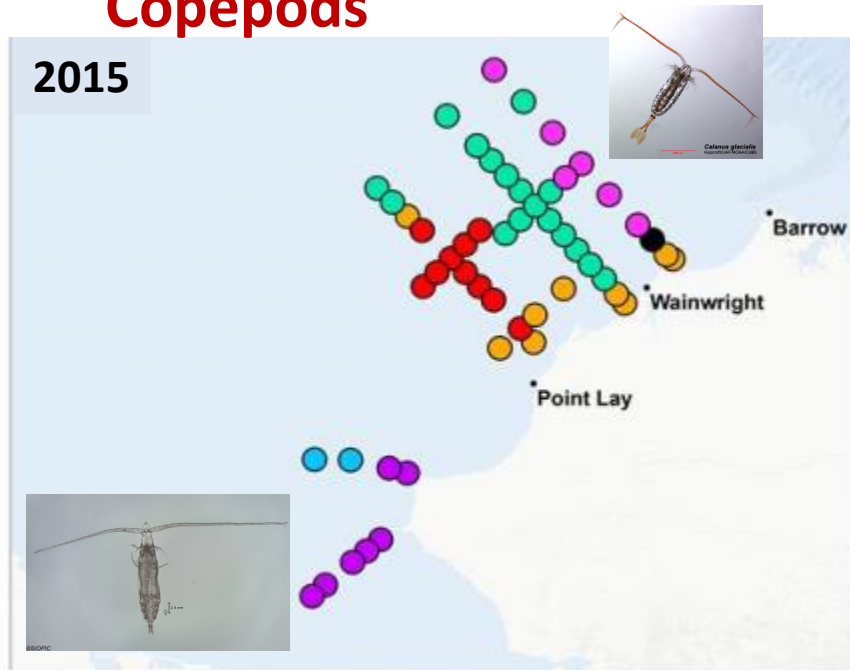
Phytoplankton



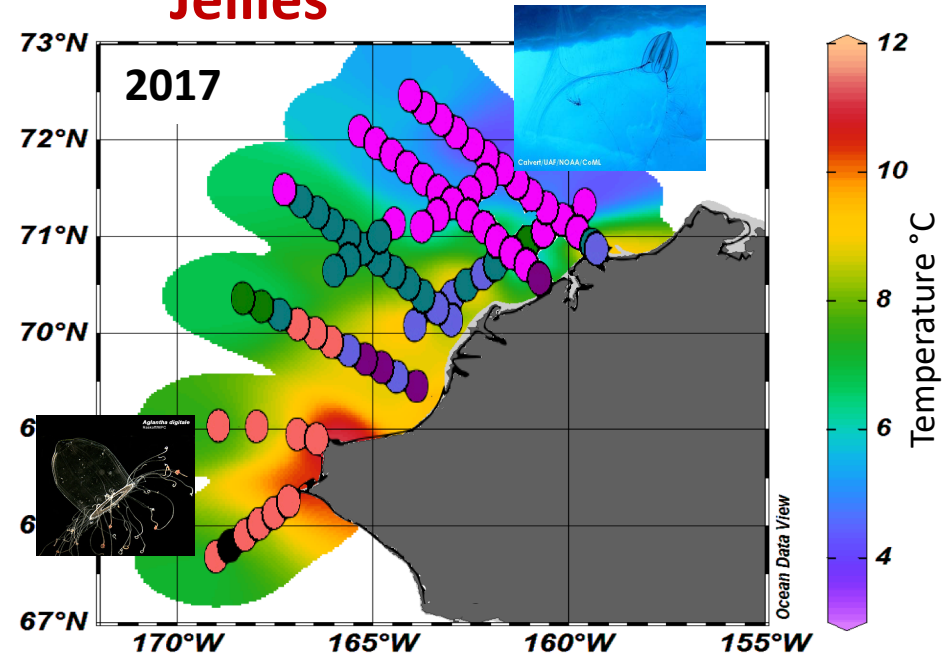


- Zooplankton strongly structured by water mass characteristics (Arctic spp in north, temperate immigrants in south)
- AMBON adds to 10-year time series on zooplankton = understanding of what is the “normal range”

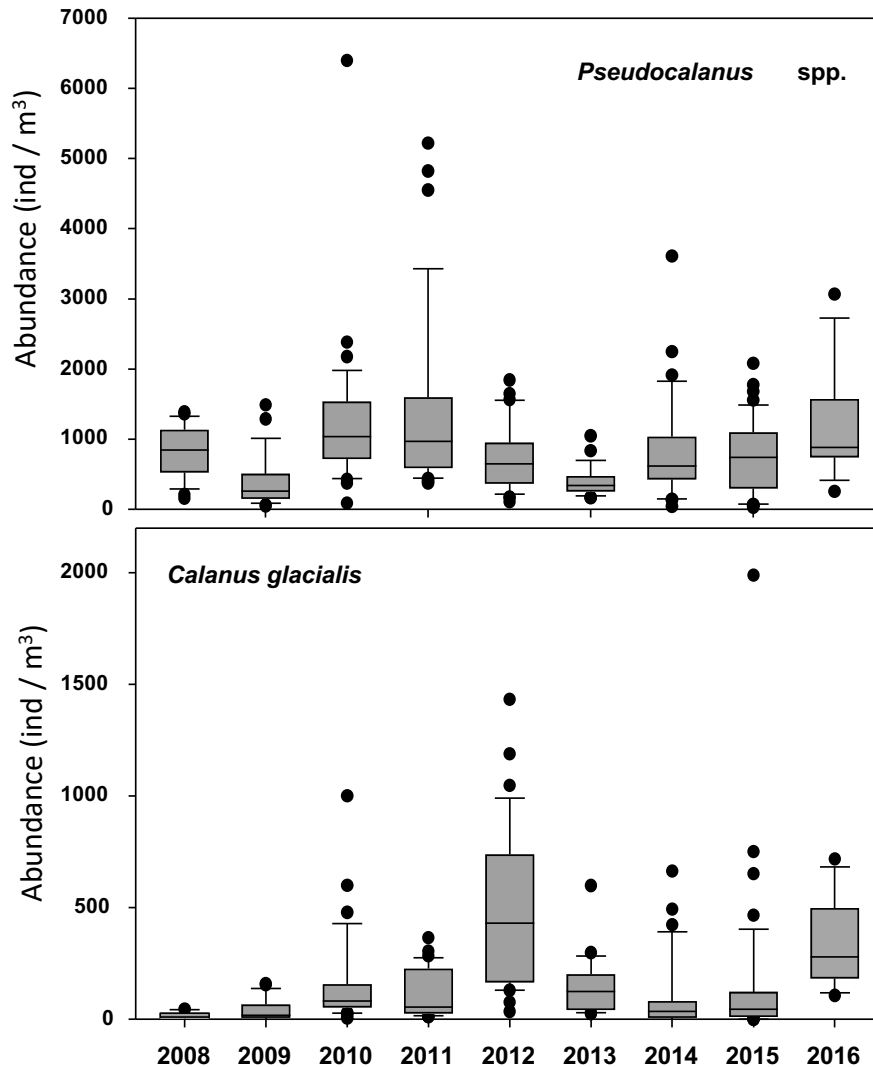
Copepods



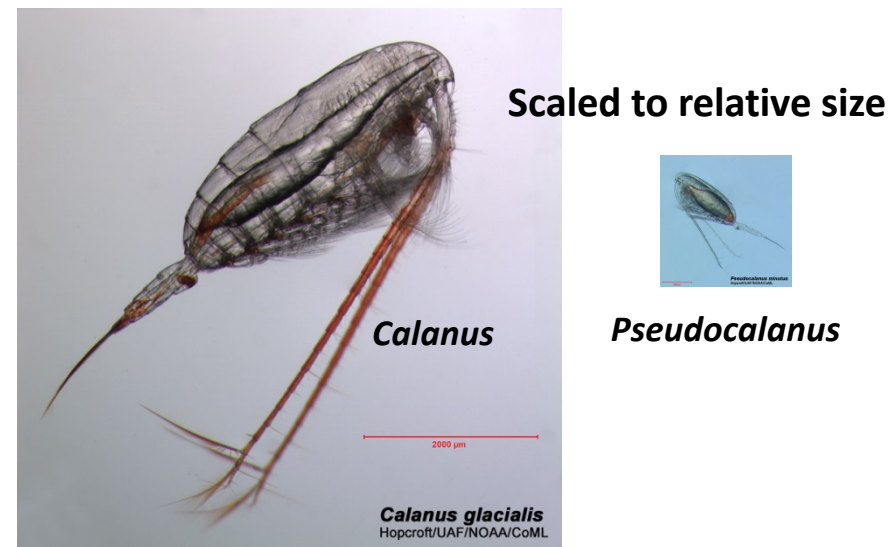
Jellies



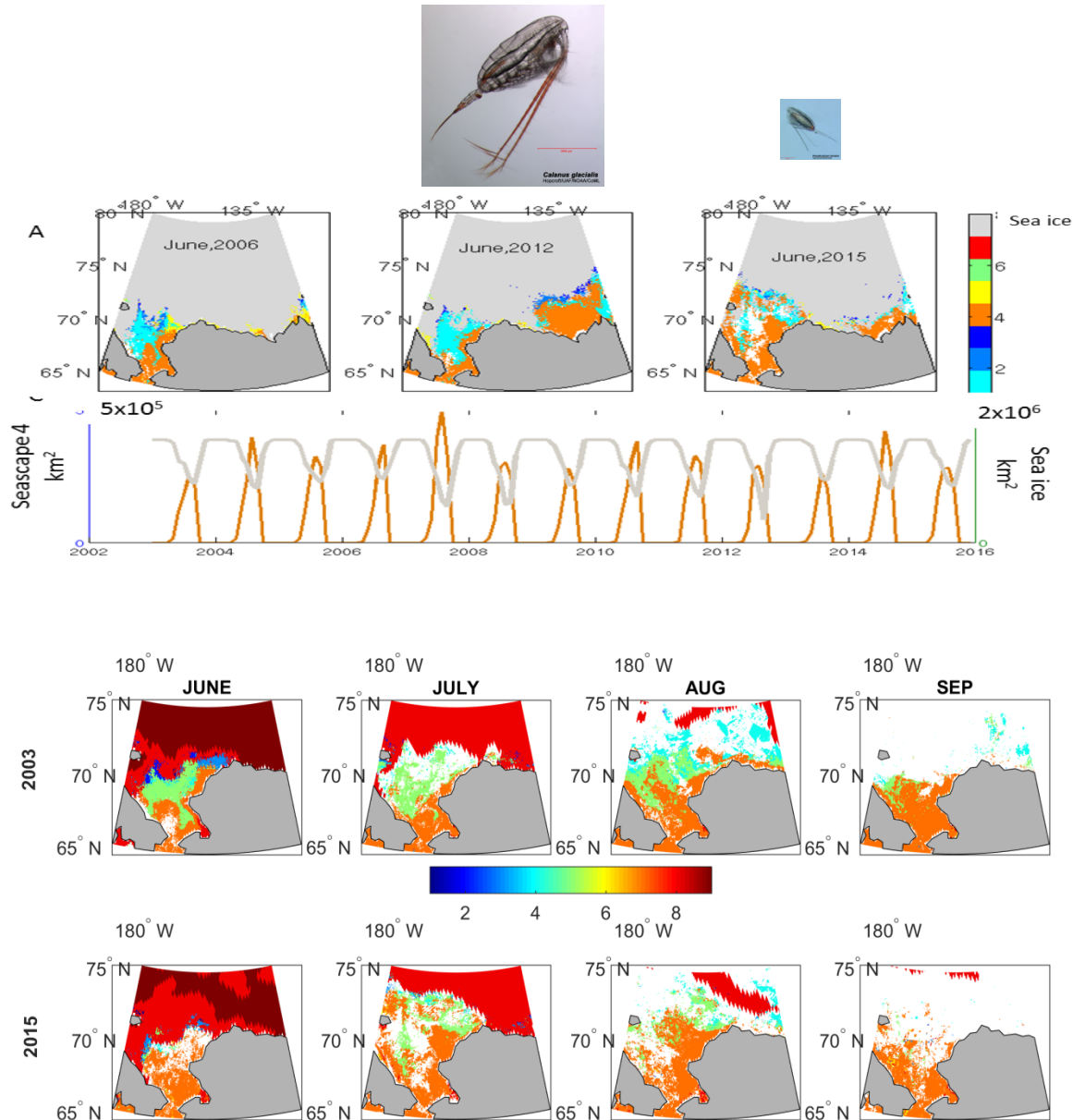
Adding to long-term data sets



- Unresolved interannual variability in zooplankton and relationship to environment
- 10-year time series in northern Chukchi Sea
- Warm years tend to be dominated by smaller-bodied *Pseudocalanus* species
- Coldest years are dominated by larger-bodied *Calanus* species



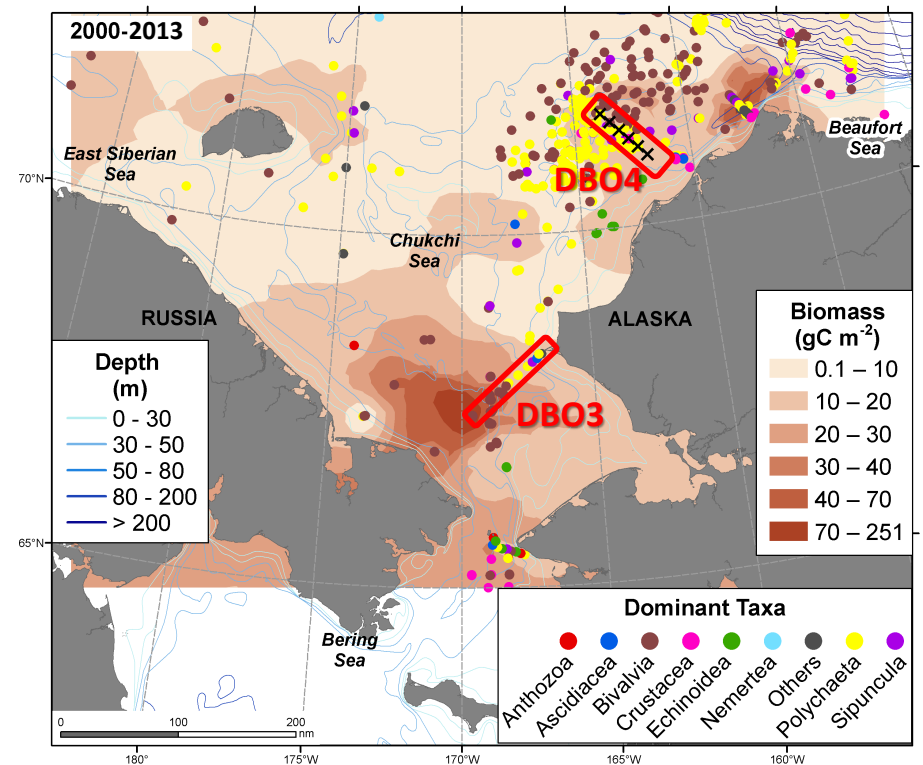
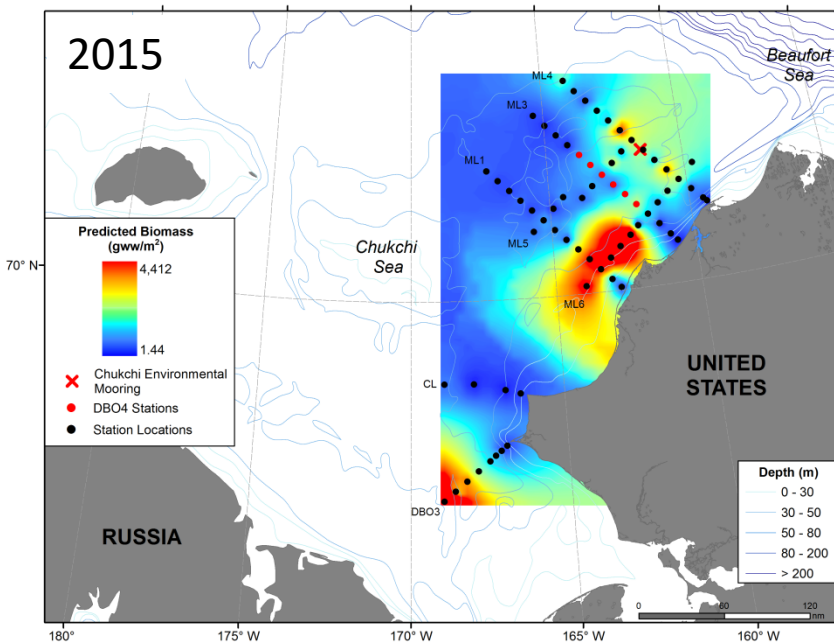
Linking long-term data to seascapes



- How do dynamic seascapes characterize pelagic habitat across the array of conditions experienced in the Arctic?
- How are pelagic habitats and species associations changing in time?
- Zooplankton data set ideal to test seascapes



- Macrofauna data add to long-term time series, persistence of “hotspots”
- Link to **Distributed Biological Observatory – DBO**
- New AMBON data inform the discussion about DBO4 line placement



AMBON data in observing planning

Fish and Epibenthos

1 *In Review at Deep-Sea Research ii (DBO Special Issue)*

2 **Does one size fit all? Observational design for epibenthos and fish assemblages in the Chukchi Sea**

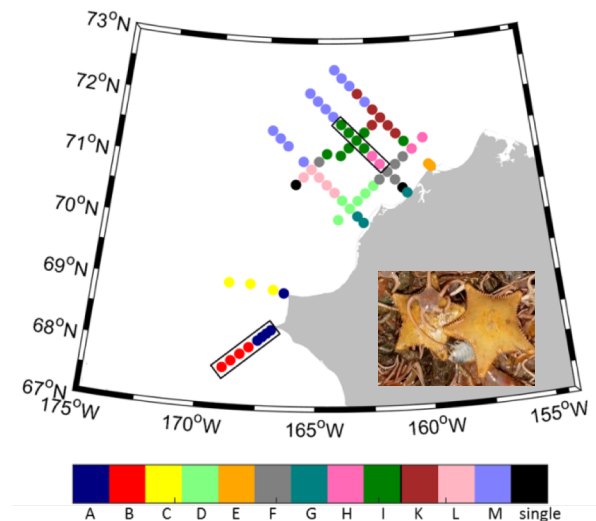
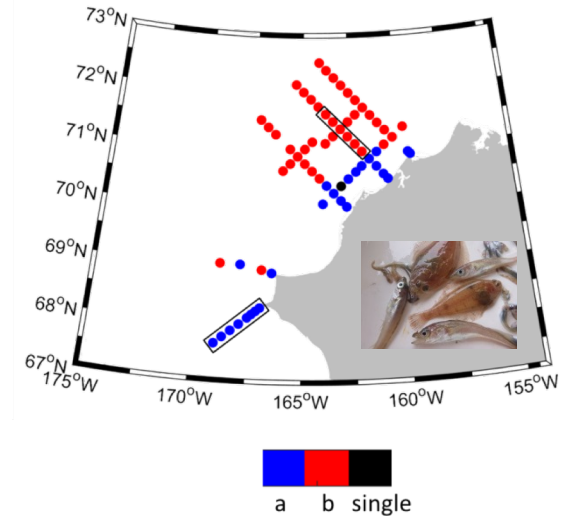
3 Iken K^{1,*}, Mueter F¹, Grebmeier JM², Cooper LW², Danielson S¹, Bluhm B³

4 * Corresponding author: kbiken@alaska.edu, phone: 907-474 5192

6 **Abstract**

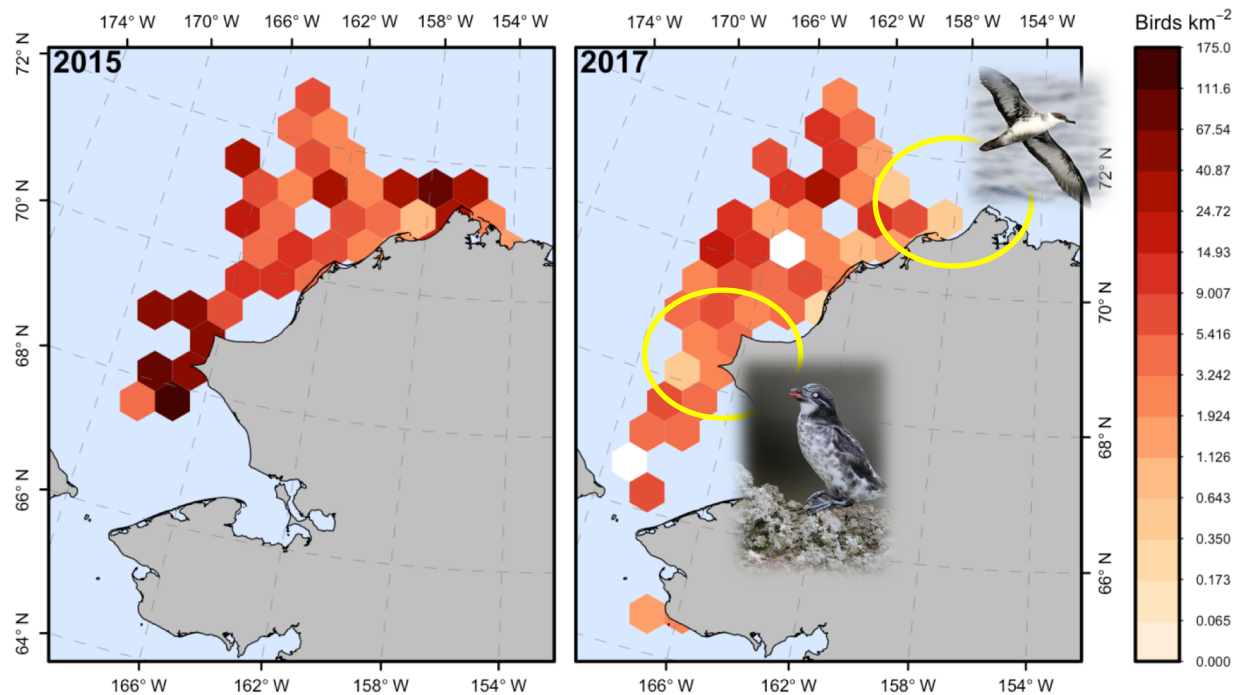
7 In light of ongoing, and accelerating, environmental changes in the Pacific Arctic Ocean, the ability to
8 track subsequent changes over time in various marine ecosystem components has become a major
9 research goal. The high logistical efforts and costs associated with arctic work demand the prudent use
10 of existing resources for the most comprehensive information gain. Here, we compare the information
11 that can be gained for epibenthic invertebrate and for demersal fish assemblages from two existing
12 long-term observational programs in the Chukchi Sea: two transects of the Distributed Biological
13 Observatory (DBO) and the Arctic Marine Biodiversity Observing Network (AMBON). The two DBO lines

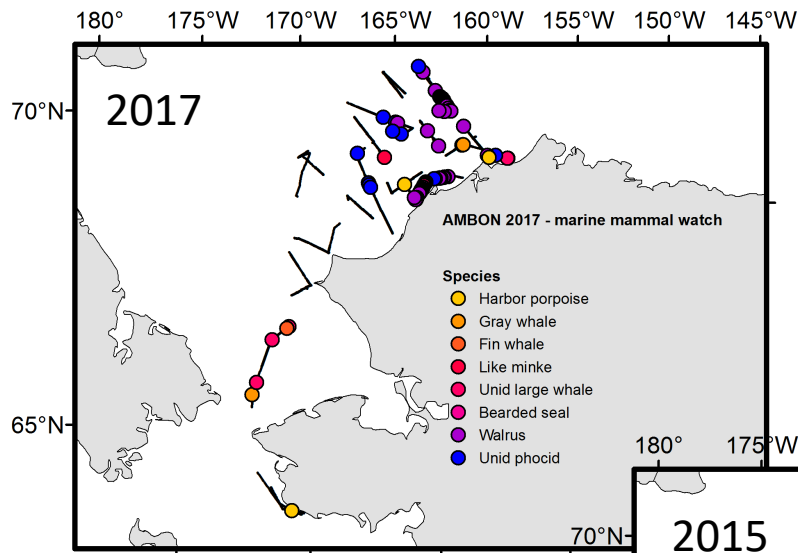
- Manuscript in review using AMBON data to assess spatial scales of epifauna and fish observations (AMBON vs DBO)
- Recommendations made for extension of DBO 4 line for fish and epifauna sampling
- Example of management application by linking DBO and AMBON



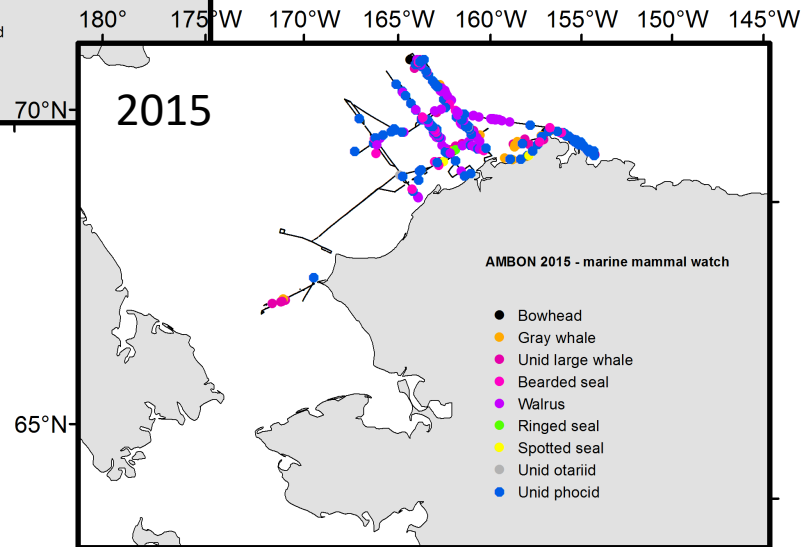


- Fewer birds in 2017 than 2015
- Less shearwaters in north and less least auklets in central breeding colonies
- Poor food conditions? Low overwinter survival?



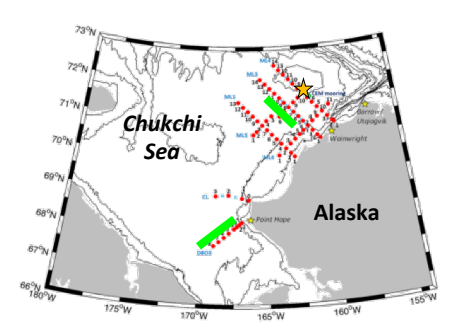


- Fewer sightings in 2017 – reduced effort?
- Walrus most abundant mammals in both years
- Concentration in northern region = traditional feeding grounds



Arctic Network

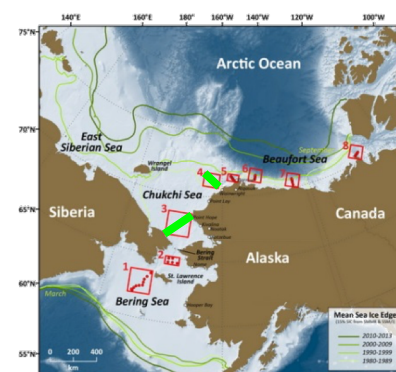
AMBON



Biodiversity focus
Large regional coverage
Microbes to whales

DBO

Distributed Biological Observatory

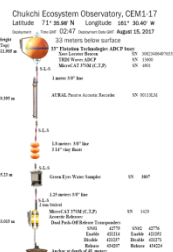
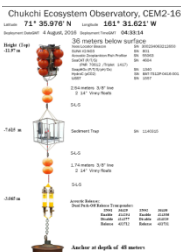


Regional biomass “hotspot” transects
Change detection array



CEO

Chukchi Ecosystem Observatory



Year-round high resolution
ecosystem monitoring &
process studies

Seasonality

Complementary

Data

Temporal scale

Spatial scale

Seascapes

Logistics

Biomass

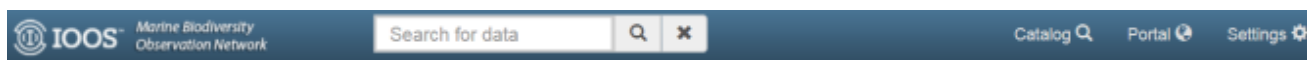
Biodiversity

Open access

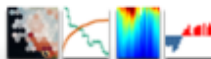
Data management



- Data discoverable through the IOOS MBON data portal
- Efforts to use Darwin Code for biological data to also link to OBIS



Marine Biodiversity Observation Network



Try the new beta version of this map. We are currently in a testing environment. Help give us feedback to improve this tool.

[Go to beta map >](#)

The Marine Biodiversity Observation Network (MBON) is composed of regional networks of scientists, resource managers, and end-users working to integrate data from existing long-term programs to improve our understanding of changes and connections between marine biodiversity and ecosystem functions. In the United States, MBON projects have been established in the Chukchi Sea (Alaska), Santa Barbara Channel (California), and the National Marine Sanctuaries in Monterey Bay (California) and the Florida Keys (Florida).

This portal provides real-time, delayed-mode, and historical data for in situ and remotely-sensed physical, chemical and biological observations focused on:

- Biodiversity observations of organisms from microbes to whales, including presence, abundance, productivity, genomic, phenology, and other relevant ecological process measurements or indices;
- Habitat characterization and habitat diversity measures, including satellite data and added-value data derived from satellite observations, and neural network model results, such as biogeographical seascape classifications.



PARTNERS



Stakeholders & Partners

Indigenous communities

- presentations at Alaska Eskimo Whaling Commission
- informational flyers distributed in communities
- daily updates sent during research cruise

Other Public & NGO Outreach

- Case study contribution to new edition of *Biodiversity and Climate Change*, edited by Thomas Lovejoy and Lee Hannah, in press, Yale University Press
- Contributions to biodiversity workshop sponsored by Conservation International
- International Biodiversity Congress, Montreal, May 2018

BOEM may use AMBON template for observing network in other Arctic regions under gas & oil development scenarios

Arctic Council – Circumpolar Biodiversity Monitoring Program (CBMP)

- AMBON PIs as expert members in CBMP
- State of the Arctic Marine Biodiversity Report (SAMBR, 2017)
- Participation of AMBON PIs in facilitating international agreements on restricting Central Arctic Ocean Fisheries (Pew Charitable Trusts)

Interagency Arctic Research Policy Committee (IARPC)

- AMBON PIs are “Marine Ecosystems” team members
- Performance element 4.1.2 Continue studies to document Arctic marine species biodiversity (e.g. Arctic Marine Biodiversity Observation Network—AMBON)...

X-MBON: GEO BON efforts, linking to essential Ocean Variables (EOV), seascapes, data management, (eDNA)

